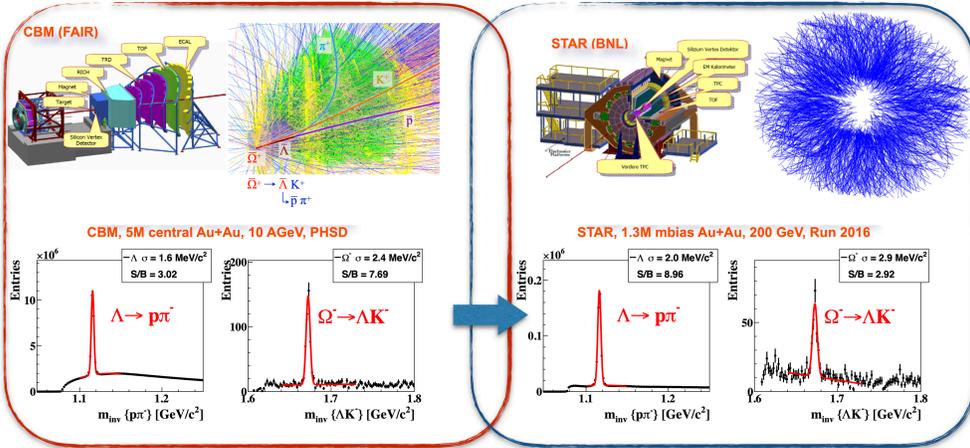


# Online Reconstruction of Long- and Short-lived Particles in the STAR Experiment

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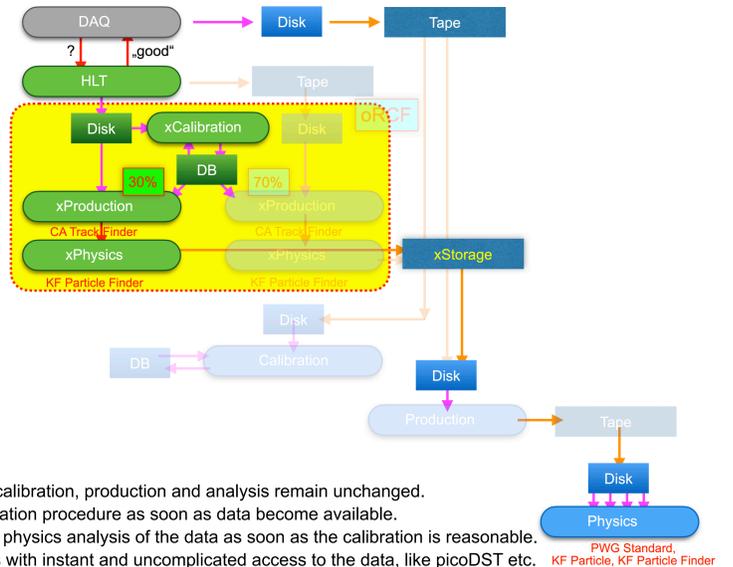
## CBM → STAR: Reconstruction and Analysis Software



- Within the FAIR Phase-0 program the CBM KF Particle Finder has been adapted to STAR and applied to real data of 2014, 2016 and BES-I.
- The KF Particle Finder provides better signal significance than the standard approach in STAR.
- The integration of the KF particle finder into the official STAR repository for use in physics analysis is currently in progress.

Use for real-time express physics analysis during the BES-II runs (2019-2021)

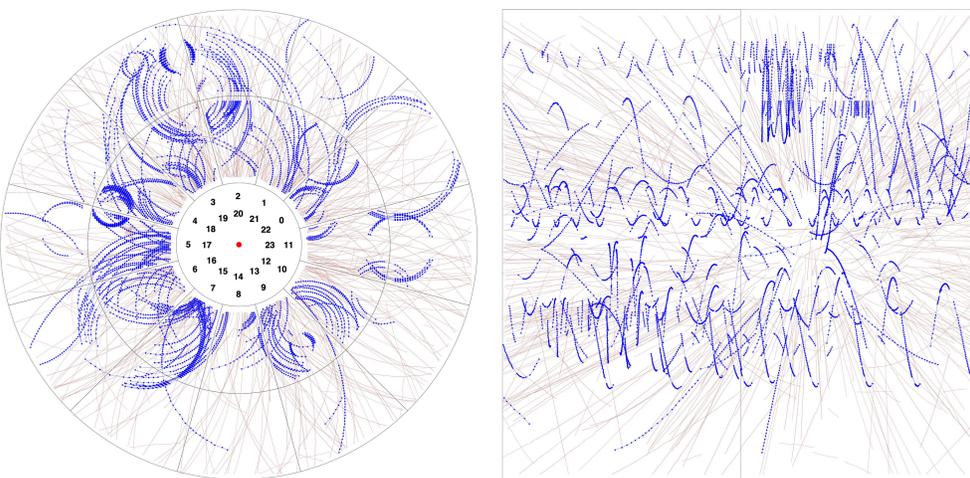
## BES-II: eXpress Data Production and Analysis



- The standard calibration, production and analysis remain unchanged.
- Start the calibration procedure as soon as data become available.
- Make possible physics analysis of the data as soon as the calibration is reasonable.
- Provide PWGs with instant and uncomplicated access to the data, like picoDST etc.

The express chain implemented on HLT is a shortest way from data acquisition to physics with online calibration, production and physics analysis

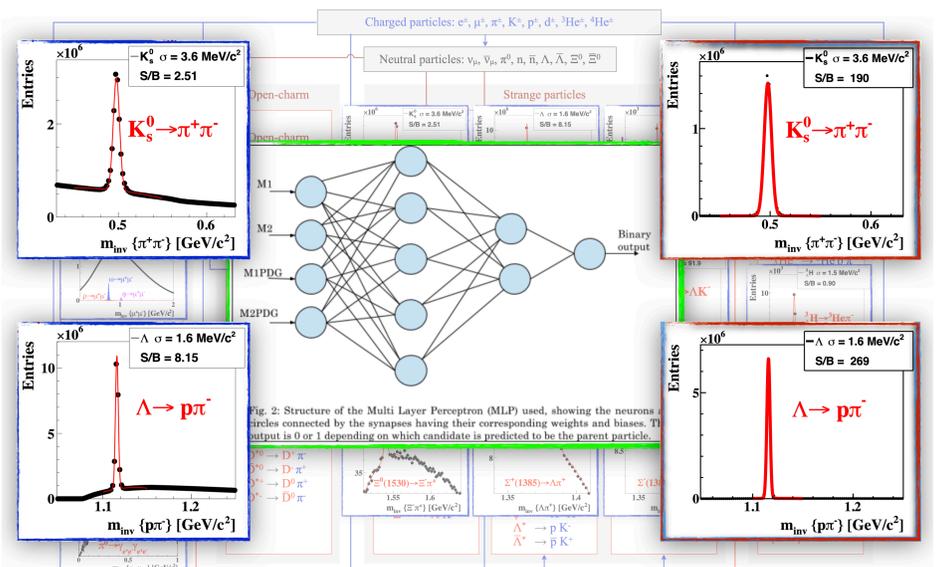
## CA: Cellular Automaton Track Finder



- The CA Track Finder for reconstruction of long-lived particles was integrated in STAR software in 2013 (online) and 2016 (offline).
- An upgraded version of the CA Track Finder featuring efficiency enhancement at very low  $p_T$  and high  $\eta$  has been used online for BES-II data processing on the HLT farm.
- The additional tracking efficiency is achieved by merging low  $p_T$  track segments into loopers.

The CA track finder has been extended to find loopers of low-momentum particles

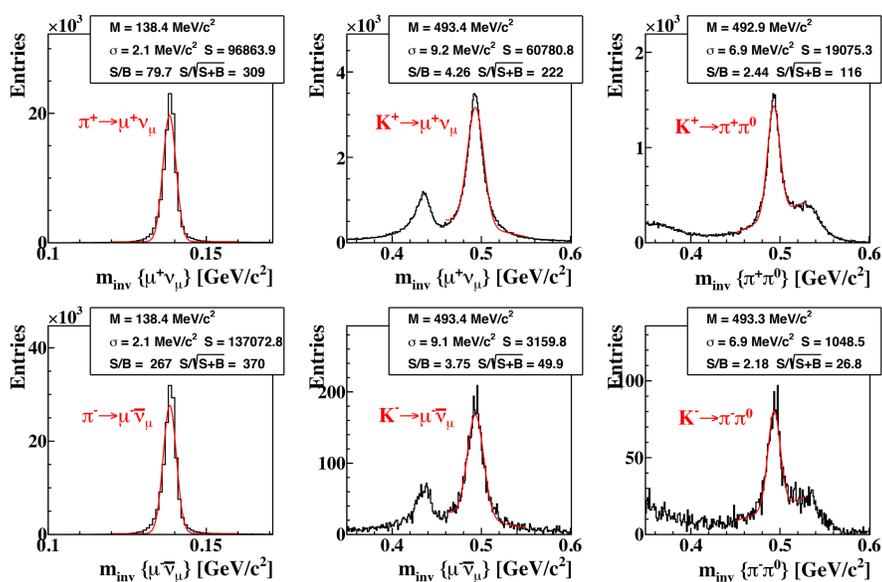
## ANN: Cleaning Decay Channels



- The KF Particle Finder package of algorithms for finding short-lived particles is now capable of finding up to 200 different decay channels, both offline and online.
- Once candidates are found in the short-lived particle search process, competition is performed between them so that the daughter particles found in only one, the most probable, decay channel.
- Two approaches have been implemented in the KF Particle Finder package to perform competition between particle candidates with possible common daughter particles: a deterministic approach and an Artificial Neural Network (ANN) approach.

The ANN approach results similar to the deterministic competition between particle candidates

## BES-II, Fixed Target, HLT eXpress Production (2021)

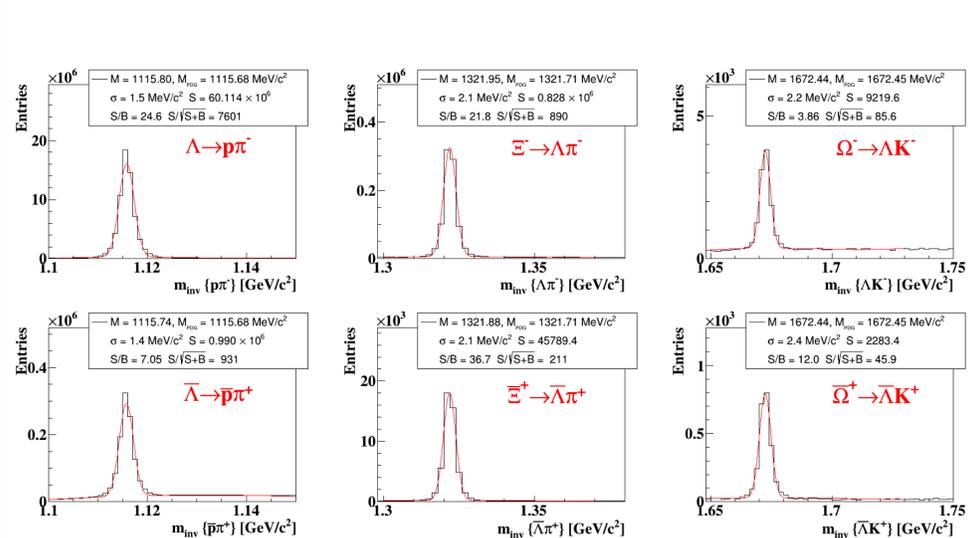


- The Missing Mass Method provides online reconstruction of short-lived particles with neutral daughter particles.
- Presented results for real data (9M AuAu events at 3 GeV) collected in May 1-2, 2021, and processed on HLT within the express production chain.

\*Second peak in K- decays resulted by misidentification of pi+ with online calibration.

The Missing Mass Method provides online reconstruction with high signal to background ratio and significance

## BES-II, Collider Mode, HLT eXpress Production (2021)



- In BES-II we see 2–4 times more signal per event compared to BES-I due to ITPC and CA Track Finder.
- Run 2021: factor 3 more  $\Omega$ /event, 2 more  $\Lambda$ /event and  $\Xi$ /event.
- All peaks are at the PDG positions with the express calibration (140M AuAu events at 7.7 GeV).

Express production allows early access to physics

## Conclusions

- ✓ The reliability and high efficiency of the FLES (First Level Event Selection) concept originally developed for the CBM heavy-ion experiment (FAIR/GSI, Germany) has been successfully proven in real-time operating conditions on the HLT farm of the STAR experiment (BNL, USA).

- ✓ The use of the FLES-based package of algorithms for online express production and analysis of data on the HLT farm within the BES-II program of the STAR experiment for three years (2019-2021) has shown the feasibility of obtaining high quality physics results practically synchronous with the data acquisition.